the heat required to theoretically unburn 1 pound of zinc is only one-seventh of that given out by the burning of 1 pound of coal. Further, it involves no commercial absurdity like that found in the calculations given in the prospectuses of many primary battery companies, which are based on zinc oxide, a material used in the manufacture of paint, maintaining its present price even if thousands of tons were produced. Unless all those who use primary batteries on this expectation intend to have the painters doing up their houses all the year round, they will find themselves possessed of the stock-in-trade of an oil and colourman on a scale only justified by a roaring business in paint.

Now about waste No. 3, the waste of power at the motor. That also is gone into fully in the discussion on Mr. Hunt's paper, and Mr. Robert Stephenson concluded that discussion by remarking "that there could be no doubt, from what had been said, that the application of voltaic electricity in what ever shape it might be developed was entirely out of the question commercially speaking. . . . The power exhibited by electro-magnets extended through so small a space as to be practically useless. A powerful electro-magnet might be compared for the sake of illustration to a steam-engine with an enormous piston, but with an exceedingly short stroke. Such an arrangement was well known to be very undesirable."

And this objection made with perfect justice against the electromotors of thirty years ago might also have been made to all the machines then existing for the mechanical production of electric currents. I have two coils of wire at the two sides of the platform joined together with two wires. I move this magnet backwards and forwards in front of this coil, and you observe the magnet suspended near the coil begins to swing in time with my hand. [Experiment shown.] Here you have in its most rudimentary form the conversion of mechanical power into electric power, and the re-conversion of electric power into mechanical power; but the apparatus at both ends has the defects pointed out by Mr. Hunt and all the speakers in the discussion on his paper—the effect diminishes very rapidly as the distance separating the coil from the moving magnet increases.

As long as electromotors as well as the machines for the production of electric currents had this defect, the electric transmission of power was like carrying coals to Newcastle in a leaky waggon. You would pay at least 16*s.* a ton for your coals in Bath, lose most of them on the way, and sell any small portion that had not tumbled out of the waggon for, say, 2*s.* a ton at Newcastle —a commercial speculation not to be recommended.

A very great improvement in electromotors was made by Pacinotti in 1860, but although his new form of electromotor was described in 1864 it attracted but little attention, probably because any form of electromotor, no matter how perfect, was commercially almost useless until some much more economical method of producing electric currents had been devised than the consumption of zinc and acids. Pacinotti's invention removed from motors that great defect that had been so fully emphasized by the various speakers at the reading of Mr. Hunt's paper in 1857. When describing his motor in the Nuovo Cimento in 1864, he pointed out that his principle was reversible, and that it might be used in a mechanical current generator. This idea was utilized by Gramme in 1870, who constructed the well-known Gramme dynamo for converting mechanical into electric power—a machine far more efficient than even Pacinotti had contemplated —and gave the whole subject of electrical engineering a vigorous forward impulse. Every subsequent maker of direct-current dynamos, or motors, has followed Gramme's example in utilizing the principle devised by Pacinotti, which was as follows. In all the early forms of dynamos or motors there were a number of magnets and a number of coils of wire, the magnets moving relatively to the coils, or the coils relatively to the magnets, as you see in this rather old specimen of alternate-current dynamo. To produce magnetism by a large number of little magnets is not economical, and Pacinotti's device consisted in arranging a number of coils round a ring in the way shown in the large wooden model [model shown], so that they could all be acted on by one large magnet. Instead of frittering away his magnetism, Pacinotti showed how it could be concentrated, and thus he led the way to dynamos and motors becoming commercial machines. Pacinotti's science, engineered by Gramme, not only made electric lighting commercially possible, but led to electricity being used as a valuable motive power. It was in their work that the electric transmission of power in its modern sense sprang into existence.

Quite recently an improvement in the same direction has been introduced into alternate-current dynamos by Mr. W. N. Mordey, for he has replaced the many magnets of the ordinary alternate-current dynamos with one large magnet, and so with his alternator weighing 41 hundredweight, which you see in this hall, he has succeeded in obtaining at a speed of 650 revolutions per minute an output of 53·6 horse-power with a high efficiency.

It may be convenient to mention at this stage the very valuable work that has been done by the Drs. Hopkinson, Mr. Crompton, Mr. Kapp, and others, in the improving of dynamos and motors by applying scientific principles in the construction of these machines. Were I lecturing on dynamos and motors instead of on the electric transmission of power, I would explain to you how, by putting more iron into the rotating armature, as it is called, and less wire on it, by shortening the stationary magnet, and generally by concentrating the magnetic action, these constructors have raised the commercial efficiency of these machines to actually as high as between 93 and 94 per cent.; further, how, by recognizing the force of the general principles laid down by Prof. Perry and myself, as to the difference that should exist in the construction of a motor and a dynamo, Messrs. Immisch have succeeded in constructing strong, durable electromotors weighing not more than 62 pounds per effective horse-power developed.

The subject is so entrancing to me, the results commercially so important, that I am strongly tempted to branch off, but the inexorable clock warns me that I must concentrate my remarks as they have concentrated the magnetic action.

87½ per cent. of the power put into an Edison-Hopkinson dynamo has actually been given out by the motor spindle when 50 horse-power was being transmitted. How does this compare with the *combined* efficiencies of an air-pump and an air-motor, or of a water-pump and a water-motor? I understand that in either of these cases 60 per cent. is considered a very satisfactory result. As far, then, as the terminal losses are concerned, electric transmission of power is certainly superior to air or water transmission.

(*To be continued.*)

SCIENTIFIC SERIALS.

THE Proceedings of the American Academy of Arts and Sciences for the year May 1887-88 contains many important papers. Among them we may mention one on the relative values of the atomic weights of hydrogen and oxygen, by Prof. J. P. Cooke and Mr. Richards, and a catalogue of all recorded meteorites, by Prof. Huntington. The volume also contains papers on the existence of oxygen, carbon, and certain other elements in the sun; the first two of these papers are chiefly remarkable for the absence of reference to the literature of the subjects, and it is charitable to suppose that this proceeds from the authors' ignorance.

Bulletin de l'Académie Royale de Belgique, June 30.—On the physical aspect of Mars during the opposition of 1888, by L. Niesten. An image of the planet taken by the author on May 5 shows that the so-called continent was again visible, which M. Perrotin had reported as having disappeared during the opposition of 1886. Analogous though less marked modifications in the form and colour of the spots seem to imply that these changes are periodical. The paper is illustrated by two successful photographs of the planetary disk, showing its appearance on April 29 and May 5, 1888.—Fresh researches on the optic origin of the spectral rays in connection with the undulatory theory of light, by C. Fievez. A new interpretation of the spectral rays is here offered by the author, who regards spectral phenomena as a particular case of optical interferences. According to this view luminous rays would produce at a given point of the spectrum a vibratory movement, whose intensity might be maximum or minimum according as one of the rays follows another by an even or uneven number of half wave-lengths. A spectrum presenting dark or bright rays would always proceed, not from a luminous source, but from at least two different sources. It would thus indicate the nature of the rays, whose undulatory movement was disturbed by the simultaneous action of the various luminous sources. M. Fievez concludes that Kirchhoff's absorption theory does not alone suffice to explain the observed facts, which may also be interpreted by means of the undulatory theory of light. His views are supported by a number of ingenious and skilfully executed experiments in spectral analysis.

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Rendiconti del Reale Istituto Lombardo, July.—Contribution to the study of unilateral hallucinations, by Prof. A. Raggi. Reference is made to two cases of what may be called "one-sided" hallucination, in one of which the left ear, in the other the left eye, was affected, the corresponding organs on the opposite side remaining perfectly sound. The complex character of the phenomena described, as well as their distinctly psychological nature, left no doubt that these were cases of true hallucination, although a subordinate influence in their production might possibly be attributed to the state of the organs themselves. On the other hand, mention was made of a somewhat doubtful case of double hallucination as connected with the same order of mental phenomena.

Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg, tome xxxii., No. 2.—On the regularity of the structure of continents, by A. Karpinsky (in German).—On a journey to the Karaites of the western provinces of Russia, by W. Radloff (in German). Those of Troki in Lithuania, Lutsk, and Kovno, are speaking a Turkish dialect with a considerable admixture of Polish, Lithuanian, and White-Russian words.—Supplementary notes with regard to the catalogue of stars published by the Pulkova Observatory, by O. Backlund.—Researches into the energy of chemical combination, by N. Beketoff (in French), being a continuation of former researches, now extended to potassium and lithium oxides.—On the polarization-photometer and its application to technical purposes, by H. Wild.—On the influence of iodoform and iodine on the isobutylate of natrium, by A. Gorboff and A. Kessler.—Notes on the new edition of the "Mi‘jâr i Jamâlî," published at Kazan in 1887, by C. Salemann, with a plate showing the kinship of various Persian dialects (all in German).

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 10.—M. Des Cloizeaux in the chair.—Remark on a point in the theory of secular irregularities, by M. F. Tisserand. The reference is to Le Verrier's statement regarding the stability of the planetary system, in connection with a certain position between Jupiter and the sun, determined at about double the distance of the earth from the sun. An attempt is made to ascertain whether there exists an analogous position, in which the originally slight eccentricity of the orbit of a small mass might gradually assume proportions calculated to disturb the general equilibrium of the system.—The French vines, by M. A. Chatin. The treatment is described, by which a vineyard at Meyzieux, Isère, has been preserved, like a green oasis, in the midst of the wilderness created round about by the combined attacks of Phylloxera, mildew, and black rot. The treatment consists partly in a systematic process of nippings (*éborgnements*), partly in the application of a strong manure, including granulated phosphorus and products, with a base of nitrogen, potassa, and lime.—Degrees of oxidation in the fluorescent compounds of chromium and manganese (continued), by M. Lecoq de Boisbaudran. Several experiments are described tending to show that the pink compound is the real cause of the fluorescence.—Observations of Barnard's new comet, made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan. This comet, discovered on September 2 at the Lick Observatory, showed on September 5 a round nebulosity from 1′ to 1′·5 in diameter, with somewhat stellar nucleus of 11·5–12 magnitude, not occupying the centre of the nebulosity.—Positions of Brooks's comet (August 7, 1888), measured at the Observatory of Besançon, by M. Gruey. The observations are for August 9–12, when the magnitude varied from 7 to 9.—On the planet Mars, by M. Perrotin. These remarks are made in connection with four new designs of Mars, forming a sequel to those published in the *Comptes rendus* of July 16. They still show the two canals—one simple, one double—running from the equatorial region nearly along the meridian towards the North Pole. A new canal is also revealed which presents the appearance of a straight dark band traversing the white Polar ice-cap.—On the chlorides of indium, by MM. L. F. Nilson and Otto Pettersson. To the previously-determined trichloride, $InCl_3$ the authors here add three distinct and stable chlorides. These are a trichloride, $InCl_3$, a dichloride, $InCl_2$, and a monochloride, InCl, showing that a metal of the third group in the natural system of the elements may act as a mono-, a di-, and a tri-valent in clearly-defined combinations.—On the part played by symbiosis in certain luminous marine animals, by M. Raphaël Dubois. In previous communications the authors showed that the fundamental reaction necessary to produce animal luminosity was of the same order as those effected under the action of the ferments. Their further studies of *Bacillus pholas* and *Bacterium pelagia*, the respective parasites of *Pholas dactylus* and *Pelagia noctiluca*, enable them to reconcile their theory of photogenous fermentation with the hypothesis of the oxidation of a phosphorated substance, as proposed by some biologists. These researches also help to explain how marine phosphorescence may be caused by the disintegration of marine animals, and how this phenomenon may cease or reappear, and assume various degrees of intensity, according to circumstances.—On the myelocytes of the Invertebrates, by M. Joannes Chatin. Hitherto spoken of as present in the organism of the Vertebrates alone, the author here shows that the myelocyte formation occurs also in the Invertebrates. He makes it evident that they cannot be assimilated to *free nuclei*, but represent true cellules normally constructed, with all their essential parts. He further points out that the intimate structure and real nature of the myelocytes may be studied much more conveniently in the lower than in the higher organisms.—On *Heterodera schachtii*, by M. Willot. In connection with his recent communication (*Comptes rendus*, August 3), on the destruction of this micro-organism by sea-water, the author points out that Dr. Strubell, of the University of Erlangen, has independently, but subsequently, made the same discovery.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Chambers's Encyclopædia, vol. ii., new edition (Chambers).—British Dogs, No. 23: H. Dalziel (Upcott Gill).—The Constants of Nature, Part 1, A Table of Specific Gravity for Solids and Liquids: F. W. Clarke (Washington).—Index to the Literature of the Spectroscope: A. Tuckerman (Washington).—Biologia Centrali-Americana: Insecta—Coleoptera, vol. i. Part 2: D. Sharp.—The Electrical Engineer. vol. i.—Examples and Examination Papers in Elementary Physics: W. Gallatly (Geo. Bell).—Massage and Allied Methods of Treatment, 2nd edition: H. Tibbits (Churchill).—British Mosses, 2 vols., new edition: F. E. Tripp (Geo. Bell).—Memorial of Asa Gray (Cambridge, Mass.)—Index to the Literature of Columbium, 1801 to 1887: F. W. Traphagen (Washington).—Annals of Botany, August (Frowde).

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